Operating and Maintenance Manual

U-15647
Pfizer
BF100W4

Water; ASME Section 4

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OPERATING AND MAINTENANCE INFORMATION

BOILER MODEL #:	BF100W4
UNIVERSAL ORDER #:	U15647
BOILER SERIAL #:	15647-1
BURNER MODEL #:	R10.1-G-30
W.O. / INVOICE #:	SO18773
BURNER SERIAL #:	AN816877
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CHAPTER I

GENERAL DESCRIPTION
MODEL BF HOT WATER BOILER

A. The Boiler

The Universal Boiler Works, Inc. (UBW) Model BF, is a 5 pass steel watertube boiler of the "O" type design. It consists of the upper and lower headers with interconnecting downcomer and flexible tangent tubes. The tubes are symmetrically installed to provide uniform gas side and water side fluid flow.

All boiler tubes are a minimum of 1.5 inches ımeter, 0.095" wall through 700 horsepower and 2 inches diameter 0.105" wall for units above 700 horsepower. Each tube is fitted with a ferrule at each end, which is press fitted into each drum hole. This method of tube attachment permits easy replacement of tubes without the need for welding or rolling. (See Figure 1-1)

Multi-bend tangentially arranged watertubes form the combustion chamber (furnace) and convection gas passes. Specific tube arrangements and the front and rear walls provide the means for gas flow direction without the use of baffles. (See Figure 1-2)

In accordance with the ASME (American Society of Mechanical Engineers) Code, the boiler is designed, fabricated, tested, and inspected following the rules of Section IV for Heating Boilers (operating at less than 250⁰ F.) Section I Power Boilers (operation at greater ıan 250⁰ F. or above 160 psig), and stamped accordingly. The location of the authorized "H" or "S" stamp is located on the upper header near the rear of the unit.

As a complete package, the pressure vessel is mounted on a 4" high insulated base frame. This base frame includes the lifting lugs for rigging purposes. Over 200 horsepower, the base is 6").

B. Casing/Insulation

A series of 11 gauge steel panels, which are bolted and sealed, provide a gas tight inner casing of up to 3" W.C. Attached to this inner casing is a 2.0 inch thick fiberglass insulation blanket rated at 2,300⁰ F.

The outer casing is fabricated of 14 gauge corrugated aluminized steel panels, underlayed with 1/2" thick fiberglass blanket insulation. A 2 inch air space between the inner and outer jackets provides additional cooling of the outer surfaces of the boiler. (See Figure 1-3 and Figure 1-4)

The combustion chamber floor is insulated with ceramic fiberboard rated at 2,000⁰ F and the front and rear walls are poured refractory rated at 2,800⁰ F. For Section I Boilers, the lower drum is insulated with a 2,300⁰ F fiberglass blanket.

Please refer to Figure 1-5 for a visual understanding of the parts and connection points that comprise the boiler. This will help in understanding your unit before start-up and for any questions that may arise, for which you require answers. Refer to the General Arrangement drawing for specific connections sizes and location dimensions. The General Arrangement drawing will also depict optional items that were added in accordance with the project specifications.

C. Pressure Parts

The BF hot water boiler has two (2) drums or headers, one upper and one lower. The upper drum is supported by the rear downcomer, front and rear walls, and steel structure. Tappings for the water temperature sensing controls are located at the front of the upper drum including the tapping for the primary low water cutoff control. At the rear of the upper drum are the tappings for the safety relief valves. The connection of the boiler water supply to the system is located at the front of the upper drum. On the top centerline of the upper drum at the front, is the vent connection. This should be piped to the expansion tank.

The lower drum, sometime referred to as the *mud drum* contains the drain connection, located at the rear bottom centerline. A drain valve should be installed to this connection by the installing contractor and piped to a safe discharge point. Do not use a hose bib connection type valve nor restrict the piping.

NOTE: The Model BF hot water boiler does not include tappings for fresh water make-up. Treated water make-up when needed, should be added via the expansion tank. A tight hot water system should have a minimal amount of make-up and a water meter is recommended to monitor the amount of water make-up.

D. Controls/Trim

The term *control* covers the electrical or electro-mechanical devices mounted on the boiler or furnished loose for field installation. These devices work in harmony with the burner controls, discussed in the burner operating/maintenance manual. *Trim* refers to mechanical items such as valves, pressure or temperature indicating devices, and piped items responding to the boiler's pressure or temperature functions. Regardless of the component, the authorized boiler operator must be familiar with all mounted and if furnished, remote mounted items that will affect the operation of the boiler.

Specific controls furnished for the project will be denoted on the General Arrangement drawing and on the Bill of Materials list.

Temperature Controls - Electrical

Please refer to Figure 1-5 for control locations.

1. Operating Limit Control - This device starts and stops the burner based on the system demand for additional heat or when the demand is satisfied.

2. High Limit Control - This device, also known as an Excess Temperature Control, stops the burner when the normal operating temperature set-point has been exceeded. Normally the device is a mechanical manual reset type, but may be wired to affect a manual reset via the combustion flame safeguard control.

3. Modulating Control - For burners which operate on the full modulation principle, this device positions the burner from low fire to high fire in response to system demand. When a

full load is required, this control will signal the burner to drive to the maximum firing position and as the load is satisfied, positions the burner to less input, eventually driving the burner to low fire for safe shutdown upon demand satisfaction. Smaller units, less than 80 horsepower, will be standardly equipped with a control that positions the burner either at full fire or low fire and is referred to or known as a High/Low Fire Control. While it is designed to respond to the system demand, it is not designed to position the burner at any point in between high or low fire.

4. Low Water Cutoff - A probe sensing device below a safe operating level. In a hot water boiler, this device should be a back up to a system water sensing device; as a low water level in a hot water boiler is very serious and will affect the longevity of the tubes.

5. Auxiliary Low Water Cutoff - (Optional) This device, when required by project specifications, can be of the internal probe sensing type or an external float actuated device. Its purpose is to shut the burner off, should the primary low water cutoff fail.

Boiler Trim

1. Boiler Water Pressure Gauge - Mechanical indicating device for visual indication of the internal pressure of the boiler (waterside).

2. Boiler Water Temperature Gauge - Mechanical device to indicate the relative water temperature at the outlet connection to the system.

3. Relief Valve(s) - Depending upon the size of the boiler, one or more water pressure relief valves are furnished. These valves are shipped loose and should be piped to a safe point of discharge by the installing contractor. The set point is generally less than the system operating pressure, to relieve water pressure within the boiler when the set point has been exceeded. Under no circumstances should the setpoint be altered above the system design nor above the boiler design pressure. Valve sizing and quantity are determined in accordance with the ASME Code. Additional valves may be added in accordance with the project specifications.

4. Stack Temperature Gauge - (Optional) When furnished, this device is shipped loose for installation by the contractor. This device indicates the outlet gas temperature of the boiler. It is normally located in the vertical rise of the stack to the boiler connection; approximately three feet above the boiler connection. Provides indication of the fireside cleanliness of the boiler.

5. Lower Header (Drum) Drain Valve - (Optional) When furnished, this valve is shipped loose for contractor piping (rear drum connection) and is used to drain the boiler for waterside inspection or when the unit is to be stored, for any lengthy period.

6. Low Water Drain Valve - (Optional) When an optional float actuated control is furnished in lieu of the standard probe control, a drain valve is furnished. This valve is factory piped to the bottom of the float housing to

permit periodic draining of the housing to remove any accumulated sludge.

E. Burner Controls

The Model BF boiler is designed for operation with a forced draft burner for natural gas, LP gas, or light oil. A separate burner manual from the specific burner manufacturer is included. In that manual are the descriptions of the various controls provided in accordance with the requirements of the Underwriter's Laboratory (U.L.) and any specific requirements of the project, in accordance with the project specifications. Within the burner manual, one will find the Burner Management Combustion Safeguard Control along with start-up instructions and combustion settings.

For fuel supply connections, refer to the General Arrangement drawing and the burner manual.

As a brief over-view, the package will contain:

1. Control Panel - Located on the burner on smaller units or on the boiler base extension at the front of the boiler. The electrical supply for the burner and controls are to be made in this panel. Any interface connections to system controls or shipped loose controls will be located within this panel.

2. Combustion Safeguard Control - Located in the Control Panel to provide safe start procedure for burner start-up, burner operation, and safety shut-down. Flame supervision is via a flame scanner which monitors pilot ignition, main flame ignition, and flame strength during operation. It is programmed to shut the burner fuel supply off in the event of an unsafe condition.

3. Forced Draft Fan - Located on the burner, provides purge air of the boiler prior to ignition and following a safe shutdown. Provides the air required for combustion.

4. Forced Draft Fan Starter - Located in the Control Panel. This device allows current flow to the fan motor upon energization of the coil. Overloads are installed within the starter to prevent damage to the motor in the event of voltage or current spikes.

5. Control Circuit Transformer- For installations operating on a 3 phase power supply, this device is located in the control panel for stepdown voltage of 120 volt single phase supply to the burner and boiler controls.

6. Damper Motor - Located on the burner to position the fuel input valve and the inlet air damper in accordance with demand requirements.

7. Gas Fuel Train - Standardly located on the left side of the boiler, when facing the front of the unit. The train for units operating on gas, as a minimum, will have a main gas pressure regulator, shutoff cocks, safety shutdown gas valves, and fuel input valve. Please refer to the burner manual for specific gas train components.

8. Pilot Train - A separate pilot regulator and pilot safety shutoff valve are furnished on the burner for gas pilot ignition.

   NOTE: Some units operating on oil may be equipped with direct spark ignition. Refer to the burner manual for specifics.

9. Oil Fuel Train - Located on the burner and as a minimum will include oil metering valve, oil pressure regulator, oil strainer, safety shutoff valves, and oil pressure gauges. Standard atomization of oil is via mechanical pressurization. Air atomization is optional. Please refer to the burner manual for specific oil components furnished.

F. Other Controls

Specific project requirements may have included controls not mentioned in this General Description section. These items can include lead/lag systems, indoor/outdoor reset, energy management interface systems, system pump interlock, etc. For specific items furnished by UBW, refer to the Bill of Materials and the Burner Manual for additional information.

It is important to understand the operation of any device, which will interface with the boiler/burner, so that all components operate as they have been selected and designed. Do not attempt to by-pass any control or device during start-up or during operation in order to expedite start-up or continue operation. Each device on the package has been furnished for a specific reason of safety or informational purposes. If a component is not operational, contact your local service agency or UBW.

Chapter 2

Unloading and Installation
Model BF Hot Water Boiler

A. Unloading

Before any attempt to unload the boiler from the transport company is made, perform a visual inspection of the boiler. Ascertain if any damage has been incurred during transit. The equipment has been loaded by UBW and accepted by the transport company as undamaged. Once the equipment has been lifted from the trailer, any damage that is not filed against the Transport Company, will be the responsibility of the rigger or purchaser.

NOTE

If the boiler will not be installed for some period of time after delivery, the unit should be protected adequately against fallen debris, the weather, etc. If extended storage will be necessary, proper lay-up of the unit should be provided to prevent oxygen pitting of the tubes. Make certain that all shipped loose or separately boxed components and controls are stored with the boiler or properly marked and located, so that when the items are required they can easily be retrieved. Check that all items have been received. Report any missing items. Items not noted as missing, within 48 hours of receipt, will not be replaced free of charge, as we will assume that the shipment has been received complete.

B. Lifting/Rigging

The Model BF boiler is equipped with lifting lugs located on each side of the boiler base frame. (Please refer to figure 2-1) These lugs have been located for the specific purpose of lifting the unit with the use of a spreader bar. A spreader is needed to prevent damage to the outside casing.

Refer to figure 2-2 for the correct placement of the spreader bar and cables.

Smaller units, depending upon the available equipment, may be unloaded via a forklift. If a forklift is used, ascertain its lifting capabilities and the use of extended forks.

Do not attach slings around the boiler or to the burner in an attempt to pull or drag the unit!

If the unit must be dragged or pulled, attach cables to the lifting lugs only. *UBW does not recommend dragging the unit for any great distance.* If the unit must be placed into a location other than lifting into place, we recommend the use of rollers.

DO NOT ALLOW THE UNIT TO BE SET DOWN UNEVENLY. IF A FRONT BASE EXTENSION HAS BEEN PROVIDED, MAKE CERTAIN THAT IT DOES NOT MAKE CONTACT IN SUCH A WAY AS TO SUPPORT THE WEIGHT OF THE BOILER. THIS COULD DISTORT THE FRAME AT THAT POINT OF CONTACT.

C. Installation

The Model BF boiler must be installed on a level surface. It is recommended that the unit be placed on a housekeeping pad to prevent water splashing during routine floor cleaning.

Although the Model BF boiler is adequately insulated and has an enclosed combustion chamber, **do not install the boiler on a combustible surface! Ascertain what the local code requirement dictates and as well, the project specifications, for the type of surface upon which the boiler is to rest.**

If the unit is to be installed on a trailer, as a portable piece of equipment, make certain that the trailer floor is adequately insulated if the floor is wood. We recommend that the floor be covered with sheet steel or some type of heat resistant covering.

Project specification will dictate the location and orientation of the boiler within the boiler room. The boiler should be located in a well-lighted area and boiler room air supply ducts should not be positioned near the rear of the boiler. Cold air hitting directly on the unit can have an adverse effect on the unit.

D. Air Supply

Adequate air supply into the boiler room for proper combustion must be provided. Under no circumstance should the boiler be operated when a negative pressure (vacuum) exists. We recommend a slightly positive condition at all times. As a rule of thumb, we recommend that a quantity of 10 cfm per boiler horsepower airflow be available, whenever the burner is operating. The location of boiler room air supply dampers should provide cross flow ventilation. The recommended size of the openings should be in accordance with Table 2-1.

Make-up air openings may be fixed or may include a motorized drive for open/close operation. If the openings are furnished with an electrical drive, check the burner electrical wiring diagram for interface connections. The burner must be started if the air dampers are closed.

E. Clearance

When placing the boiler, ensure adequate service and maintenance space is provided. As a minimum, a 30-inch space should be allowed at the rear of the boiler, a minimum of 30-inches at the front of the boiler for burner servicing and for each side. Refer to the General Arrangement drawing for aisle space requirements; project specifications may require more room. (See Figure 2-3)

NOTE: Project specifications and/or local codes may require more service clearance space than noted above.

To ensure ease of access to the tubes, **do not install the unit against a wall or other supporting structures.** This will prevent access panel removal. The outer and inner casings are removable to provide access to the tubes from each side of the boiler. There is an access door at the back of the boiler for access to the combustion chamber. Keep this in

mind when placing piping, etc. at the back of the unit and along the sides.

As an option, access panels located at the rear of the unit for cleaning and inspecting the convection passes, may have been furnished. Check the general arrangement drawing if these have been furnished to ascertain if clearance at the rear will be adequate for tube surface brushing.

F. Connections

Local codes and project specifications will dictate the requirements for all interface connections of fuel, water exhaust and electrical. Those requirements must be adhered to and inspected by the authority having jurisdiction for the installation. UBW is only noting the location of the connections for reference, along with other recommendations not conflicting with code or specification requirements. (Refer to the general arrangement drawing for connection locations, sizes and types.)

1. Stack or Breaching – This connection is located on the top centerline of the boiler at the rear. The specific size and dimensioned location are noted on the General Arrangement drawing. If a vertical stack is furnished, do not allow the boiler to be the support for the stack. The stack should be supported from the roof trusses or another means of stack support should be provided.

   Do not permit the stack to slide past the boiler connection so that it rests on the upper drum. This will create a backpressure and seriously affect combustion and leakage of combustible products.

   The stack outlet should be fitted with some means of preventing ingress of rain as shown in Figure 2-4.

2. System Supply/Return – The hot water supply connection to the system is located on the upper drum at the front, and the system return connection is located at the rear of the lower drum. **For multiple boiler installations,** it is recommended that balancing valves be installed in the return line, to 9insure equal flow to each boiler, at the required flow rate. (See Table 2-2)

3. Air Vent – To ensure that entrained air is not allowed to accumulate, an air vent tapping is located on the top drum centerline at the front. This connection should be piped to the expansion tank. San auto air vent valve can be used, but **is not** recommended in lieu of expansion tank piping.

4. Boiler Drain – For draining the boiler, a tapping is located on the bottom drum centerline at the rear. Connect an approved valve to this opening and pipe to a safe and approved discharge point.

   NOTE: For Section I high pressure boilers or as local codes or specifications may dictate, one quick opening and one slow opening valve shall be installed to the bottom drum drain connection. The valve closest to the drum shall be the quick open type. directly into the boiler. For most effectiveness, we recommend that the chemicals be introduced into

the feed tank, prior to boiler introduction.

5. Relief Valve(s) - These items are shipped separate and must be mounted direct to the boiler without any intervening shutoff devices. The connections are located in the rear top drum. Discharge piping shall follow local code requirements.

WARNING!

Improper handling or installation of a relief valve may adversely affect the valve's operation, resulting in serious damage to property and life.

Observe the following precautions when installing relief valves.

- Use only flat jawed wrenches on the flats of the valve.
- Do not use a pipe threaded into the outlet connection of the valve to turn the valve.
- Avoid over tightening, which can distort the valve's seating ability.
- Apply only a moderate amount of pipe compound to male threads only.
- Discharge piping must be used if the discharge is located where workers might be scalded.
- Discharge pipe diameter must be at least equal to the size of the safety valve.
- If discharge piping extends greater than 12 feet, use a ½" diameter larger for each 12 feet length.
- Avoid all 90° bends if possible.
- If discharge terminates outdoors where it can be subjected to freezing, ensure appropriate measures prevent the discharge pipe from freezing shut.
- Each discharge pipe should have ⅜" or ½" open drain at its lowest point.

Refer to Figure 2-5 for a recommended method of safety valve discharge piping.

6. Electrical – Follow local codes and the National Electric Code (NEC) for connection of the main power supply and any external interfaces connections. Power connection points are provided in the burner control panel. Refer to the burner-wiring diagram for details.

7. Gas Fuel – If the burner is equipped to burn gas, the gas train is located on the left side of the boiler when facing the burner. (Note: project specifications may locate the train on the opposite side, or it may have been shipped not mounted for a specific location). Local codes will govern the supply line connection to the boiler but should include a drip leg and strainer prior to the connection at the boiler. Refer to the burner gas train drawing for vent line details of the individual components. (NOTE: Do not run the supply line flush to the side of the boiler, which will hamper casing removal)

8. Oil Fuel – Refer to the burner manual for specific controls and components. If an integral oil pump is furnished, this will be located at the burner to which the suction and return lines are to be connected. If a remote pump is furnished, project specifications will note the location and piping.

Follow local specification and governing code guidelines for fuel piping.

G. Water Treatment

The following layout, marked **Hot Water Generator Room Plan** shows two hot water boilers feeding two heating zones.

A stand-by pump is shown to pump either of the two zones. This is possible only if the water flow and pipe friction is practically the same for each zone.

The expansion tanks are shown connected to the top of the low water cutoff (if a float operated control is used, otherwise connect to the vent connection on the upper drum) to prevent air binding in the control or drum. The cold water make-up line is connected to the expansion tank header, and make-up should be treated and softened.

An isometric view is given to show the piping for hot water operation in the 180° to 240° F ranges. The system shown describes the popular pump-out system, with the pumps installed on the hot water line leaving the boilers. This system offers the advantages of constant water pressure in the boilers with the expansion tank connected to the boilers. Also, on high friction head systems, the pump discharge is not imposed on the boilers and standard Section IV boiler units can be used, provided extreme static head pressure does not exist.

The return water enters the bottom rear drum of each unit and the hot water supply take-off is from the top front drum. The run-out should include an elbow that moves the shut-off valves off the boiler centerline, allowing the valves to be accessed without climbing onto the boiler.

A balance cock is shown for each boiler and must be utilized. It is impossible to perfectly balance the flow of water through each boiler simply by piping design or via the use of gate valves. Unequal flow will impact the proper response and load demand on each boiler.

Zone three-way valves should be designed for proper pressure drop to prevent hunting and they should be of the slow open and slow close type. Never allow the valves to fully close so that the flow may be established through each boiler. Should the heating demand not require the use of more than one unit for any lengthy period, it is recommended that the boilers not used be properly valved out. System pumps should be interlocked with the burners to prevent burner operation unless the pump(s) is operating.

NOTE

Pressure vessel warranty is subject to proper water treatment. If water treatment is not undertaken, pressure vessel warranty is voided.

H. Gas Connections

The safety of a gas-fired boiler installation is controlled by the care taken in the application of gas accessories to the combustion equipment on the boiler. Figures A, B and C describe some of the various applications of gas services as well as some of the details that should be taken care of, to ensure that a safe and efficient installation is secured.

Figure A shows an incorrect method of connecting gas service to a boiler. As show, it is impossible to check the pilot on the boiler without disconnecting the electrical head to the main gas valve. It is not recommended that the pilot line be down-stream from the main manual shut-off valve.

Figure B shows the correct method of connection of the pilot line to the main gas line. With this hook-up, it is possible to shut-off the main gas valve and run the burner on pilot only, so that an efficient, stable flame can be secured by proper adjustment. After the pilot is properly adjusted, the operator or server technician can then open the main gas valve and be assured that the boiler will light properly. Some gas companies may require an additional gas valve ahead of the pilot connection.

It is extremely important that vent piping from gas regulators, solenoid vent valves or check cocks be installed correctly to prevent the escape of gas into the boiler room, in the event of improper operation or by failure of a gas regulator diaphragm. The gas vents from the boiler should be ample size and not less then ⅜". One-quarter inch copper piping, that is seen often in boiler installations should be avoided, as it is easy to plug up such small vent piping, leading to an unsafe operation of the gas accessories. The gas vents should be terminated outside of the building wall and be equipped with a bug screen type vent cap. As shown in **Figure C**, vents from test cocks or vent valves should not be combined with vents from gas pressure regulators.

As shown in all three figures, it is preferable to run the gas drop (drip or dirt leg) all the way to the floor, thus providing support of the gas piping as well as a dirt pocket, to catch welding spatter or scale, before it enters into the gas train components. (Note: keep the gas drops behind and away from the side of boiler to permit removal of side casing and tube pull from the boiler)

Note

Keep the gas drop behind and away from the side of the boiler to permit removal of side casing and tube pull from the boiler.

The manual shut-off valve should be of the lubricated plug type or ball type, not a cone type brass cock. A lubricated plug valve will not freeze and become difficult to turn. This valve should be equipped with a permanently attached handle that indicated whether the valve is opened or closed.

The requirements of local gas utilities, local and national codes should be checked carefully, before making the final connections of the gas service to the boiler. As a minimum, the gas train

components should be in accordance with the latest UL standards for gas fired equipment.

I. Light Oil Circulating Pump

Oil piping requirements vary with different types of burners and the specific burner manufacturers' data should be consulted, to determine specific pumping requirements. Burners that operate with mechanical pressure atomization of oil for combustion must be known, so that line size is proper for adequate oil supply at high fire.

Mechanical oil atomization generally utilizes the burner pump to increase the oil pressure at the oil nozzle, for proper atomization. Consequently, the oil flow to the suction side of the pump **must be at least twice the firing rate capacity at high fire.**

The illustration shows the installation of a light oil transfer pump for a multiple boiler installation. The drawing depicts the preferred method over pressurized supply lines or small storage tanks in the boiler room.

The suction line between the tank and the circulating pump should be tested for 24 hours under 100-psig-air pressure; to insure that it is tight before it is covered. One oil pump is shown as only one pump is usually installed, if oil is a stand-by fuel. If oil is the primary fuel, two pumps should be installed in parallel. If two pumps are used or if gate valves are installed in the discharge line, the pumps should be equipped with safety relief valves.

The oil loop room the pump to the boilers and back to the tank should be located in a trench, if possible If it is necessary to locate the loop over the boilers, a check should be made to insure that the pumps on the boilers could with stand the suction pressure imposed by the height of the loop.

NOTE:

Per NFPA standards, the pressure imposed on the suction side of the boiler-mounted pump **may not exceed 3 psi.** Therefore, a pressure-reducing valve may be required.

By raising the end of the loop up one foot, a positive supply of oil is available at all times on the suctions of the pumps at the boilers. If the oil loop is located in a trench, the end of the loop should be raised at least one foot above the elevation of the pumps on the boilers.

This system has a number of advantages over pressured supply lines or small storage tanks. These are:

1. Minimum of pressure required in the oil supply line.
2. Minimum amount of oil storage is required in the boiler room.
3. No floats switches, pressure regulators or relief valves required, other than noted above.
4. Oil cannot spill out of vents or overflows that are required on other systems.

J. Electrical

Power Supply to the boiler must be protected with dual element fuses or circuit breakers. Similar fuses should be used in branch circuits. Standard one-shot fuses are not recommended.

Information in Table 2-4 is included as a guideline of fuse protection requirements and these should be confirmed with project specifications, burner provided, and should be in accordance with the latest NEC (National Electric Code) requirements and local governing codes.

It is recommended that Emergency Power Disconnect switches be located at each entry into the boiler room. These switches should be interlocked with the boiler/burner control circuit.

Make sure that all external wiring to and from the control panel is properly identified and marked. This is to ensure that if burner power is disconnected, other power sources are known and marked, which may remain active within the panel, even though the burner power has been disconnected.

Check that the wiring diagrams for the burner and boiler controls are contained in the control panel print pocket at all times. Reference these drawings for external connections that may require interface wiring with other controls. If these drawings are not available, check with your local UBW Representative.

Chapter 3

Model BF Boiler
Initial Start-Up and Operation - Hot Water

A. General Preparation for Start-up

Before initial burner firing is undertaken, be certain that all connections have been completed and secured. Make certain that the vent, water, fuel, electrical services are complete and that interruptions will not occur during the start-up procedure.

NOTE: IF THE UNIT IS INTENDED FOR TEMPORARY SERVICE, CHECK WITH UBW FOR WARRANTY IMPLICATIONS!

Pre-start Checklist:

- ✓ Electrical Service connected/protected?
- ✓ Motors properly connected for rotation?
- ✓ Fuel-supply piped and fuel available?
- ✓ Exhaust vent/breeching connected and free of obstructions?
- ✓ Combustion Air Make-up available?
- ✓ Interface wiring completed to external controls or devices?
- ✓ Water supply piped?
- ✓ Drain and Relief Valves piped?
- ✓ Inspection completed?
- ✓ Sufficient Load demands available for setting combustion and controls?

B. Cleaning

During fabrication of the boiler, heating surfaces are subjected to cutting oils, grease, etc. These must be removed prior to full operation of the boiler. To accomplish this, a boil-out of the unit is recommended. This procedure can be carried out along with the cleaning the system, and can be accomplished during the time period to cure the front and rear wall refractories.

The entire system should be cleaned including the boiler, before full operation of the boiler is permitted. Piping connected to the boiler may contain oil, grease, or other materials detrimental to pumps and the boiler. These impurities, if not removed, will adversely affect the heating surfaces of the boiler. Chemical cleaning of the system piping is necessary and the entire system drained after cleaning. If the boiler is replacing an existing unit within an existing system, boil-out of the system modifications, impurities may be introduced and it is recommended that an existing system be reviewed for cleanliness.

C. Refractory Curing

The front and rear walls for the BF unit are constructed of high temperature refractory. Before initial firing of the unit, these should be checked for any damage that may have occurred during

shipment of the boiler. Any hairline cracks should be wash coated with a lightweight cement mixture.

To provide longer life of the refractory, it is recommended that the refractory be cured properly prior to full fire operation. During fabrication and while the unit was under installation, the refractory absorbed a goodly amount of moisture. This contained moisture must be driven off slowly to prevent rapid expansion of the material that could lead to large cracks and eventual overheating of the exterior steel surfaces. Please refer to the separate procedure covering refractory curing.

D. Boil-out

Boil-out - Refer to the water content of the installed boiler shown on Table 3-1. If the boiler will be cleaned with the system note the additional amount of water relative to the required chemicals. An alkaline solution should be used during the boil-out period.

PROCEDURAL STEPS FOR BOIL-OUT:

CAUTION!

Chemicals used for boil-out are injurious to eyes and skin. Refer to the Material Safety Data Sheet for proper safety equipment and protection, and required precautions. Always wear eye protection and **rubber gloves when handling boil-out chemicals.**

1. Remove upper and lower drum handhole covers and inspect all internal surfaces. Remove any debris and wash with a water hose. Close lower handhole cover.

Make sure that the relief valve(s) is removed from the boiler to prevent any chemicals or sludge accumulation on the valve seat.

2. If the **boiler only** is to be boiled out, connect an overflow pipe to one of the relief valve connection openings. This pipe should have a tee connection for adding chemicals as needed during the boil-out period.

   a. Fill the boiler with clean water just below the upper drum handhole opening. Water temperature must be at least 70°F.

   b. Add the cleaning chemical using a pump. Never add the chemical into the boiler before adding water.

   c. Close the upper handhole cover and add more water until water begins to flow out the overflow pipe.

   d. Recheck all burner controls and light the burner. Make sure the burner is in the manual firing position and at low fire. Fire the boiler intermittently until the water reaches the boiling point.

DO NOT PRODUCE PRESSURE!

   e. When boiling temperature has been established, hold at this point for at least five hours. If

the refractory is being cured, keep the curing process in mind during the boil-out period.

f. During the boil-out period, open the bottom drain valve once every hour. Allow this to remain open for a count of 5, then close. Add more water until overflows. Check the alkalinity periodically. When the alkalinity falls below 3000 ppm, add more chemical solution.

g. Intermittently, add more water to allow an overflow of water to carry off surface impurities. Continue this process until the water clears.

h. The time period for boil-out will vary in relation to the size if the boiler, and as well, if the refractory is being cured. Generally, a boil-out should take no more than 24 hours for the largest units (300 hp to 800 hp) and less than 12 hours for smaller units. Cleanliness of the waterside is confirmed by water clarity.

i. Upon completion, shut the burner off and allow the water temperature to drop to approximately 120° F. Drain the boiler.

j. Remove the handhole covers in both drums and wash the waterside surfaces. Inspect the surfaces and if not clean, repeat the boil-out procedure.

k. Replace the handhole covers with new gaskets and attach the relief valve(s).

l. If the boiler will be placed into operation shortly after boil-out, fill the unit with clean treated water and fire the unit to reach at least 180°F. If the unit will not be used right away, prepare the unit for lay-up storage.

3. If the boiler and system will be cleaned jointly, an overflow pipe may be used, with a shut-off cock, to check the cleanliness of the system water. However, the addition of the cleaning chemicals should be introduced via a shot feeder or via the expansion tank.

   a. Make sure the boiler relief valve(s) is removed during system/boiler cleaning.

   b. Follow the burner firing and refractory curing notations as described for boiler only boil-out.

E. Refractory

The refractory used in the construction of the Model BF watertube boiler has been chosen for the intrinsically good insulating properties and longevity and reduces maintenance and/or repair substantially.

To avoid rapid expansion of moisture contained in the refractory, caused by immediate full load firing, the following refractory curing schedule should be accomplished. Once the curing process has been accomplished, normal-operating procedures can be permitted.

Set the burner to the low fire position. The curing process will follow a period of low fire operation with an increase in firing rate throughout the curing period.

Hour 1: Fire for 5 minutes, stop for 10 minutes alternatively. (5 on, 10, off, etc.)

Hour 2: Fire for 5 minutes, off for 5 minutes alternatively.

Hour 3: Fire for 10 minutes, stop for 5 minutes alternatively.

Hour 4: Increase firing rate between low and mid range; fire for 15 minutes, and off for 5 minutes alternatively.

Hour 5: Continue firing at the rate noted in hour 4.

Hour 6: Position firing rates at mid-point and continue firing as noted in Hour 4.

Hour 7: Increase firing rates to 75% and continue firing.

Hour 8: Increase firing rate to 100% and continue for approximately 3/4 of an hour then slowly turn down to low fire. If boil-out is being accomplished, continue with the boil-out procedure.

Note: On units below 150 horsepower, the curing time can be reduced by 50%. This means that during hour 4, the firing rate may be increased proportionately throughout the hour.

Note: Once the curing process has begun, it should not be interrupted.

Note: Before boil-out or refractory curing is undertaken, the burner should be properly adjusted for proper fuel input and fuel/air ratio. Improper fuel/air ratio can cause incomplete combustion and sooting of the fireside surfaces. Refer to the burner manual for proper burner adjustments.

F. SEQUENCE OF OPERATION

Refer to the burner/boiler-wiring diagram, the combustion safeguard control manual, and the burner manual for specific reference to the combustion safeguard control furnished. A more detailed discussion is contained in the technical information booklet covering the specific combustion safeguard control. However, the following is an overview of the burner/boiler sequence of operation.

The burner and control system are in starting condition when the following conditions exist.

Boiler and system are filled with water and the low water control probes or float control confirm correct water level. The operating limit temperature control and high limit temperature are below their respective cut-off settings. All entrance switches are closed and power is present at the line terminals of the forced draft fan starter. Power must also be present to the oil pump starter for remote oil pumps for burners operating on oil fuel.

The sequence of operation does not attempt to correlate the action of the fuel supply system, system pump interlocks, combustion air damper interlocks, and pertain specifically to the action of the combustion safeguard control.

1. Circuit and Interlock Controls

The burner control circuit is a two-wire system designed for 120 volt, single phase, 60 hertz, alternating current.

Control circuit power is extended to the combustion safeguard terminals L1 and L2 and simultaneously, to the burner air inlet damper motor.

The controls used in the inlet circuit vary depending upon the fuel - oil or gas - and the specific requirements of applicable regulatory bodies. Refer to the wiring diagram to determine the controls provided. The controls normally used are:

-Control Power On-Off Switch
-Gas-Oil Switch (Combination Fuel Units)
-Operating Limit Temperature Control
-High Limit Temperature Control
-Low Water Cutoff Control
-Low Gas Pressure Switch
-High Gas Pressure Switch
-Proof or Closure Valve End Switch

Controls used in the running interlock circuit are:

Blower (Forced Draft Fan) Motor Starter
Combustion Air Proving Switch

With the programmer energized, the following sequence occurs automatically:

Pre-Purged Period

When the burner control switch is placed in the *on* position, power is routed through the limit controls and the limit proving circuit, internal to the combustion safeguard control is proven, provided that all limits are made. With the limits proven and if supplied, the gas fuel valve end switch proves that the gas valve is closed (fuel valve interlock circuit), the forced draft fan starter is energized.

Internal circuitry provides power to the burner air inlet damper motor and the air damper drives to high airflow position. Depending upon code requirements, the damper will go to the full open position and if a high fire position switch on the damper has been furnished, the switch must be made before the combustion control will allow the damper to return to low fire position for trial for ignition.

Provided that the damper has proved full airflow and the running interlocks have been proven closed (combustion air interlock closed) the combustion safeguard must sense that the damper has returned to the low fire start position.

This is accomplished via the low fire end switch on the damper motor. When this switch closes the combustion safeguard will begin the sequence for ignition.

Ignition Period

Upon proof that the damper motor is at low fire (damper at minimum airflow), internal circuitry of the combustion safeguard energizes the ignition terminal. The burner's ignition transformer is energized and the pilot solenoid valve is opened and the pilot flame is ignited.

When the flame detector senses a sufficiently strong pilot flame within a 10-second period, the main fuel valves are energized and main flame is ignited. The flame scanner must detect main flame within a 15-second trial period so that the combustion sequence may proceed. If flame is not sensed, the combustion safeguard will cause an automatic shutdown of the fuel valves and cycle the burner to the off position and energize the alarm circuit.

Automatic Load Response

When the main flame has been established, the combustion safeguard places the damper motor into the auto response the boiler's modulating temperature and limit controls. Depending upon the position of the modulating temperature control the burner will modulate from low to high fire in response to system demand.

As the heating demand becomes less, the damper motor will automatically drive to a lower firing rate and eventually, as demand becomes satisfied, burner will return to the low fire position. When the burner has returned to low fire and the demand has been satisfied, the operating limit control will open and the burner will turn off and commence a short post air purge period.

When post purge air has been completed, the forced draft fan will shut off automatically and the combustion safeguard will await the next signal for load demand and re-start the above sequence automatically.

Loss of Flame

The combustion safeguard control will prevent start-up or ignition if the pre-ignition or airflow interlocks open. The controls lockout switch must be manually depressed following a safety shutdown. A short cool down period is necessary before the switch button can be depressed and operation resumed.

Caution!Caution!

The cause for loss of flame or any unusual condition should be investigated and corrected before attempting to restart.

Please note that the combustion safeguard control is a solid state device with no moving parts. DO NOT attempt to by-pass the control nor attempt to repair if found to be defective. Tampering with the control or bypassing the sequence can lead to injury. If the control does not respond properly contact your local sales/service representative or Universal Boiler for assistance.

Chapter 4

Model BF Hot Water Boiler
Boiler Controls, Operation and Adjustments

This chapter pertains to the controls furnished on the boiler. Please refer to the burner manual for control settings pertinent to the specific burner furnished with the boiler. Boiler and burner controls must be properly set for safe and reliable operation of the package.

The specific project may include controls not listed in this chapter. Please refer to the Bill of Materials for controls that may be installed external to the boiler. Other devices may interface with the boiler/burner controls and their operation and adjustments undertaken to properly interface with the operating controls of the boiler and burner. Refer to the individual items included as an addendum to this chapter.

A. Controls, General

The controls furnished with the Model BF boiler standardly include:

Operating Limit Temperature
Excess Temperature
Burner Positioning
Low Water Cutoff
Water Temperature Gauge
Pressure Gauge
Pressure Relief Valve

Individual manufacturer's catalogue cut sheets are included at the end of this chapter for these devices.

The gauges and relief valve are pre-set and require no adjustments.

B. Control Purpose

The controls selected for the boiler are for the safe and reliable operation of the boiler. Tampering with, improper setting, or by-passing the controls could lead to seriously unsafe conditions, and will void the warranty of the control and boiler. Each device has a specific purpose in proper operation or serves as a safety device to prevent equipment or personal injury.

DESCRIPTION:

Operating Limit Control - This control is an auto open or closure switch to permit the boiler/burner start sequence to occur. Via a sensing element located in the upper drum, the control switch will close when water temperature falls below the controls' "on" set-point. When water temperature reaches the controls' "off" setpoint, the controls switch will open to shut the burner off.

Excess Temperature - Sometime referred to as the High Limit Control, this device is provided as a safety control to discontinue operation if the operating limit control fails to open. Normally the control is a mechanical reset device although it may have been wired to affect a manual reset via the Combustion Safeguard Control. This controls' set-point is always set above the set-point of the operating limit control but below the maximum operating temperature limits of the system.

Burner Positioning - This control responds to the system demand and positions the burner firing

rate accordingly. On units from 80 horsepower and above, the control is a modulating type while on units below 80 horsepower the control is a high/low positioning control as a standard.

When heat is required, this control will affect the relative firing rate of the burner, depending upon the heat requirement in the system. Relative to the demand, this control will signal the burner firing rate at low fire or high fire or somewhere in between. On full modulation operation, the control will permit the burner to be positioned relative to tracking the demand rate of the system requirement. When demand is satisfied, the control will signal the burner to drive to the low fire position before shutdown.

Low Water Control - This device is furnished to prevent burner operation if a low water level occurs in the boiler. Normally a hot water boiler has no operating water level as the boiler must be flooded at all times for safe operation. However this control if furnished as a safety device, if for some reason water flow is prevented and water is removed from the unit by some means during operation. It is not however a device that proves sufficient flow through the boiler.

The device [standardly] is an internal probe while a float actuated control is optional. When a probe is furnished, correct conductivity of the water permits continuity between the sensing probe and ground. So long as this conductivity permits current path completion, the control will permit burner operation to begin or to continue.

C. Operation and Adjustment

Refer to Figure 4-1

Operating Limit Control - Honeywell L4008 Series is the standard control. Refer to the system temperature requirements for the project for desired operating temperature. The operating range for this control is 110-240 degrees, with and adjustable differential from 5 to 30 degrees F.

Adjustable Differential - This is the temperature difference between the on - off operation of the control. For example, if the open switch set point is 190 and the differential is 15, the switch will close when the temperature drops to 175.

Minimum Set Point - Under no circumstances will UBW accept a control set point below 160 and a differential greater than 20 degrees at this set point.

Minimum Differential - UBW recommends that the differential be no less than 10 degrees for the operating limit control. A narrower differential may interfere with proper circulation through the boiler to keep the heat transfer rates proper.

Control Adjustment

Operating Limit - When the required operating temperature of the system has been verified, turn the dial on the **operating control** to the *off* set point. Verify the designed return water temperature and be certain that the differential is not greater nor less than noted above. The control set point should be approximately 10 degrees above the system required temperature, that is, if the system is to maintain 200 degrees F., set the operating limit control @ 210 degrees F.

High Limit - This control should be set at a minimum of 20 degrees above the operating limit control. **NOTE: For a 30 psi relief valve setting, this control must not be set above 240° F!**

Modulating Control - For full modulating burner operation, this control positions the damper

motor from minimum fire to maximum rate. It's setting is relative to the set point of the operating limit control.

There are two adjustments required; one for the set point (temperature to be maintained in the system); one for the modulating range or span in which the burner will modulate between low and high fire. Please note that the operating limit control must be set higher than the set point of the modulating control, to prevent the boiler from turning off at high fire or prior to its' low fire position.

Example: Desired system temperature to be maintained is 180° F. Turn the controls' dial to the 180 degree mark and turn the proportioning range adjustment wheel (located on the side) to 20. This setting provides a modulating range between 170 and 190. With the operating limit control set at 200°, this allows the burner to drive to the low fire position for proper and safe cutoff as the temperature nears this set point.

Never set the Operating Limit Controls set point at the same setting as the Modulating Control or below the set point of the Modulating Control.

Set points and throttling ranges may have to be readjusted after the initial settings to provide proper system control, and the above is noted as a guide only. Consideration must be given to system three-way valves and Building or Energy Management Systems. Proper interface must be accomplished so that the boiler is not turned off inadvertently at high fire.

Figure 4.1 depicts the relationship between the operating limit control and the modulating control. The burner will be on whenever the temperature is below point B and off whenever the temperature is above Point A. The gap between Points A and B represents the on-off differential of the operating limit control.

In normal operation, the burner will shut down whenever the temperature reaches setting A. The switch in the operating limit control will open. When the temperature drops to B (set-point minus differential), the operating limit control switch closes and the burner is cycled on. At this set-point, the modulating control will position the burner's damper motor at low fire. If the load demand exceeds this low fire set point, the modulating control will signal the damper motor to drive the burner toward more fuel input. As the demand increases, the modulating control will move toward point D and the burner will respond to fire at an increased rate to its maximum rate. Whenever the load demand changes, the firing rate will change accordingly, which is commonly referred to as *modulated firing.*

Point D represents the maximum firing rate of the burner. In the event temperature drops further from this set point, either the load exceeds the rating of the burner/boiler, or insufficient fuel flow has occurred.

Although a gap is shown between B and C, these points may well coincide if required by load conditions. When set as shown, the burner will be in a low fire position upon restart and will fire at that rate for a short period of time before falling temperature requires an increase in the firing rate. From the illustration one can see that this recommended operation will not be achieved if setting C overlapped point B. In that event, upon a restart, the burner would drive to a higher firing rate immediately.

When firing a cold boiler, it is recommended that the burner be kept under manual flame control until normal operating temperature is approached. The fuel input may be increased gradually via the manual flame control and the manual auto switch in the manual position.

required above these points, consult with the :al Boiler Inspector and UBW/Universal.

The reason why a boiler should not operate above 240 degrees pertains to the set-point of the operating limit control. It is against code to have the excess water temperature control set higher than 250 degrees. At this set-point, the operating limit control differential is insufficient for proper operation.

When initially firing a newly installed boiler or when bringing an idle boiler on line with operating boilers, the idle boiler *must* be pressurized equal to the system and other boilers before adding it to the system.

We recommend that a thermometer be installed in the return line to indicate return water temperature. If balancing valves have not been installed, it will be difficult to ascertain proper flow into the added boiler. Please refer to Table 1 for the recommended flow rates, relative to e temperature differential between the supply and return water.

When the idle boiler has been brought on line, make certain that the air vent is utilized to expel any entrained air within the upper drum.